REMARKS

This is intended as a full and complete response to the Final Office Action dated December 21, 2005, having a shortened statutory period for response set to expire on March 21, 2006. Please reconsider the claims pending in the application for reasons discussed below.

Claims 1-31 remain pending in the application and are shown above. Claims 1 - 31 stand rejected by the Examiner. Claims 1, 3, 17, 22, and 25 are amended to correct matters of form and these amendments are not presented to distinguish a reference, thus, the claims as amended are entitled to a full range of equivalents if not previously amended to distinguish a reference. Reconsideration of the rejected claims is requested for reasons presented below.

Claim Rejections – 35 USC § 112

Claims 29-31 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. In addition, the amendments filed October 6, 2005 stand objected to by the Examiner under 35 U.S.C. 132(a) because it introduces new matter into the disclosure and 35 U.S.C. 132(a) states that no amendment shall introduce new matter into the disclosure of the invention.

The Examiner states that Claims 29-31 recites the limitation of "wherein the ionic membrane is positioned at a vertical position above the anode and in substantially parallel relationship to an upper surface of the anode" (claim 29) and the limitation of "the upper surface of the anode is tilted between about 3° and about 30° from horizontal" (claim 31), however, there is no evidence in the applicant's disclosure to support the recitation of the limitations above. The Examiner asserts that the disclosure on page 8 teaches that the components of the plating cell are tilted but does not explicitly say that the anode is tilted and, therefore, does not provide a clear indication to support the new limitations. The Examiner further states that Applicant is required to cancel the new matter in the reply to this Final Office Action.

Applicant respectfully traverses the rejection on ground that claims 29-31 are supported by the Specification and Drawings at least at paragraphs 20-24, 31-32, 35, and Figures 1 and 5 without introducing new matter. For example, as illustrated in

Figure 1, a membrane 112 is positioned vertically above an anode 105 and in parallel relationship to an upper surface of the anode 105. Accordingly, Applicant respectfully submits that, as recited in claim 29, "wherein the ionic membrane is positioned at a vertical position above the anode and in substantially parallel relationship to an upper surface of the anode" is supported by the specification and the drawings.

As another example, paragraph 20 states that "As illustrated in Figure 1, plating cell 100 is generally positioned at a tilt angle, *i.e.*, the frame member 103 of plating cell is generally elevated on one side such that the components of plating cell 100 are tilted between about 3° and about 30° ..... such that the uppermost point of inner basin 102 is generally horizontal" and paragraph 22 states that "since frame member 103 is elevated on one side, the upper surface of base member 104 is generally tiled from the horizontal at an angle that corresponds to the angle of frame member 103 relative to a horizontal position. Base member 104 includes an annular or disk shaped recess formed therein, the annular recess being configured to receive a disk shaped anode member 105". According, the components of plating cell 100, the frame member 103, the base member 104, and the disk shaped anode member 105 received on the recess of the base member 104 are tilted between about 3° and about 30°. Applicant respectfully submits that, as recited in claim 31, "wherein the ionic membrane is positioned at a vertical position above the anode and in substantially parallel relationship to an upper surface of the anode" is supported by the specification and the drawings. Withdrawal of the rejection is respectfully requested.

Claim Rejections – 35 USC § 103

Claims 1-3, 5-10, 13-14, 19-27 and 29 stand rejected under 35 U.S.C. 103(a) as being obvious over *Mayer et al.* (U.S. Patent No. 6,257,920) in view of *Reid et al.* (U.S. Patent Application No. 2001/0015321). The Examiner states that *Mayer et al.* teach a method for plating copper onto a substrate, comprising: positioning the substrate in a catholyte solution (column 19 lines 16-23), the solution comprising: an acid source at a concentration of between about 0-250 g/L (column 20 lines 11-15); a copper source at a concentration of between about 10-50 g/L (or about 0.2-0.8 M, column 20 lines 5-15); one or more additives (column 19 lines 16-28); and hydrochloric acid (column 20 lines 11-15); and applying a plating bias between the substrate and

an anode (column 4 lines 5-10), where the anolyte also has the same concentration of copper of 10-50 g/L (column 4, lines 28-31) and is substantially free of organic additives (column 7, lines 14-17). Regarding the limitations of the catholyte of between about 0.8 M and about 0.9M and the anolyte of greater than about 51g/L, the Examiner also states that a prima facie case of obviousness exists where the claimed ranges and the prior art ranges do not overlap but are close enough that one skilled in he art would have expected them to have the same properties. The Examiner also states that *Mayer et al.* does not explicitly teach the concentration of the chloride ions nor the pH of the anolyte solution, whereas *Reid et al.* teaches a copper source at a concentration of between about 10-60 b/L (or about 0.16-0.94M) and chlorine ions at a concentration of between about 20-200 mg/L (or about 20-2000 ppm), which are within the claimed range. The Examiner asserts that it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the electroplating method of *Mayer et al.* by the chloride concentration of *Reid et al.*, because such concentration is suitable for electroplating to produce such metal films and features. Applicant respectfully traverses the rejection.

Mayer et al. discloses an electroplating apparatus including a porous transport barrier between an anode and an cathode to separate an anolyte and a catholyte and prevent mixing thereof, (*See*, Abstract and Summary.) without using an ionic membrane. The porous transport barrier of *Mayer et al.* comprises a material including porous glasses, porous ceramics, silica areogels, organic aerogels, porous polymeric materials, and filter membranes, such as a sintered polyethylene, a sintered polypropylene, a carbon filter layer, or a three-layer membrane including a first layer of porous material sandwiched between two additional layers of porous material. (*See*, column 4, line 59-67, column 5, lines 1-7.) *Reid et al.* teaches a method of plating copper onto a substrate in a solution without using an ionic membrane.

Accordingly, *Mayer et al.* in view of *Reid et al.*, alone or in combination, does not teach, show or suggest an anolyte chamber being separated from a catholyte chamber by an ionic membrane. Therefore, *Mayer et al.* in view of *Reid et al.*, alone or in combination, does not teach, show, or suggest positioning the substrate in a catholyte solution contained in a catholyte chamber of a plating cell and applying a

plating bias between the substrate and an anode positioned in an anolyte chamber of the plating cell, the anolyte chamber being separated from the catholyte chamber by an ionic membrane and being supplied with an anolyte solution, wherein the catholyte solution comprises one or more additives and the difference between the catholyte solution and the anolyte solution is that the catholyte solution comprises the one or more additives, as recited in claims 1, 10, 19, 25, and claims dependent thereon.

Regarding claim 29 and claims dependent thereon, *Mayer et al.* does not teach, show, or suggest any ionic membrane positioned at a vertical position above the anode and in substantially parallel relationship to an upper surface of the anode. *Mayer et al.* in view of *Reid et al.*, alone or in combination, does not teach, show or suggest positioning a substrate in a catholyte solution contained in a catholyte chamber of a plating cell, the catholyte solution comprising a copper source at a concentration of between about 0.8M and about 0.9M and one or more additives, and applying a plating bias between the substrate and an anode positioned in an anolyte chamber of the plating cell, the anolyte chamber being separated from the catholyte chamber by an ionic membrane and being supplied with an anolyte solution comprising a copper source at a concentration of greater than about 51 g/L, wherein the ionic membrane is positioned at a vertical position above the anode and in substantially parallel relationship to an upper surface of the anode, as recited in claim 25 and claims dependent thereon. Accordingly, withdrawal of the rejection and allowance of claims 1, 10, 19, 25 and 29, and claims dependent thereon are respectfully requested.

Claims 15-16, 28 and 30 stand rejected under 35 U.S.C. 103(a) as being obvious over *Mayer et al.* in view of *Reid et al.*, and further in view of Woodruff et al. (U.S. Patent Publication No. 2001/0032788). The Examiner states that *Mayer et al.* does not teach an electroplating method wherein an ionic membrane comprises a fluorized polymer matrix or a polydivinilbenzol matrix, and *Woodruff et al.* teaches a NAFION perfuorinated membrane. The Examiner also states that it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the electroplating method of the one by using the membrane of *Woodruff et al.*,

because the perfluorinated membrane would reduce the consumption of additives. Applicant respectfully traverses the rejection.

Mayer et al. and *Reid et al.* have been discussed above.

Woodruff et al. discloses an electrochemical processing chamber 200 and an interface member 700, which is a filter or ion-membrane designed to be positioned vertically in order to allow a secondary fluid flow F_2 to pass and join a primary fluid flow F_p, and prevent bubbles from the secondary fluid flow F_2 to pass, forcing bubbles in the secondary fluid flow F_2 to rise. (*See*, paragraphs 81, 83, 86-89.) When the interface member 700 is an ion-membrane, it prevents particles, organic additives, and bubbles in the secondary fluid flow F_2 to pass through into the primary fluid flow F_p and eliminates the consumption of the additives at the anode and the need to replenish the additives at the anode because the additives supplied to the secondary fluid flow F_2, which can be an anolyte, do not affect the primary fluid flow F_p. (*See*, paragraphs 88-89.) Thus, the anolyte of *Woodruff et al.* in the secondary fluid flow F_2 includes additives and can not be passed through into the primary fluid flow F_p. *Woodruff et al.* does not describe the difference between a catholyte solution and an anolyte solution is that the catholyte solution comprises one or more additives.

Accordingly, *Mayer et al.* in view of *Reid et al.*, and further in view of *Woodruff et al.*, alone or in combination, does not disclose or suggest a plating cell including an ionic membrane positioned to separate an anolyte volume from a catholyte volume and a difference between a catholyte solution and an anolyte solution is that the catholyte solution comprises one or more additives. Neither *Mayer et al.*, *Reid et al.*, nor *Woodruff et al.* discloses an ionic membrane, a catholyte solution comprising additives, and an anolyte solution comprising no additives. There is no motivation to include an ionic membrane which separates an anolyte volume containing an anolyte solution without additives from a catholyte volume containing a catholyte solution with additives, from the combination of *Mayer et al.*, *Reid et al.*, and *Woodruff et al.* Applicant asserts that the Examiner has not supplied the requisite motivation from the combination of references to combine the teachings of *Mayer et al.*, which discloses a catholyte solution comprises organic additives and an anolyte solution comprises no organic additives, with the teachings of *Woodruff et al.*, which disclose an ionic

membrane to separate two fluid flows that both contain additives. Applicant submits that "[t]he showing of a motivation to combine must be clear and particular, and it must be supported by actual evidence. *In re Dembiczak*, 50 U.S.P.Q. 2d 1614, 1617 (Fed. Cir. 1999).

The Examiner has failed to show a clear and particular motivation by the skilled artisan to select from the combined disclosures of *Mayer et al.* with *Reid et al.* and *Woodruff et al.* On this point, the Federal Circuit has ruled that "[o]ne cannot use hindsight reconstruction to pick and choose among isolated disclosures in the prior art to deprecate the claimed invention." (*In re Fritch* at 1784). In order to avoid using the Applicant's disclosure as a blueprint to pick and choose certain elements, while ignoring others, the Examiner must supply a clear and particular motivation or suggestion to do so. In the present case, the only suggestion is provided in the Applicant's disclosure and thus hindsight.

Furthermore, the compositions, methods or steps of *Mayer et al.*, *Reid et al.* and *Woodruff et al.* are each distinctly described and, in combination, provide no suggestion, motivation, or expectation of success for the claimed subject matter. Therefore, *Mayer et al.* in view of *Reid et al.*, and further in view of *Woodruff et al.*, alone or in combination, do not teach, show, or suggest positioning the substrate in a plating cell, wherein the plating cell includes a catholyte volume containing a catholyte solution, an anolyte volume containing an anolyte solution, an ionic membrane positioned to separate the anolyte volume from the catholyte volume, and an anode positioned in the anolyte volume, applying a plating bias between the anode and the substrate, plating copper ions onto the substrate from the catholyte solution, and replenishing the copper ions plated onto the substrate from the catholyte solution with copper ions transported from the anolyte solution via the ionic membrane, wherein the anolyte solution has a copper concentration of greater than about 51 g/L and the difference between the catholyte solution and the anolyte solution is that the catholyte solution comprises one or more additives, as recited in claims 10, 25, which claims 15-16, 28 and 30 are dependent thereon. Withdrawal of the rejection is respectfully requested.

Claims 4, 11, 12, 17 and 18 stand rejected under 35 U.S.C. 103(a) as being obvious over *Mayer et al.* in view of *Reid et al.*, and further in view of *Dahms et al.* (US Patent No. 6,099,711). The Examiner states that *Mayer et al.* do not explicitly teach an electroplating method wherein the accelerator comprises sulfo propyldisulfide and *Dahms et al.* teaches an electroplating method for copper having an accelerator comprising of bis-(w-sulfopropyl)-disulfide, disodium salt (Table 2). The Examiner also states that it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the combined method of *Mayer et al.* and *Reid et al.* by using the accelerator of *Dahms et al.*, because a sulfo propyldisulfide accelerator is a suitable additive for electroplating copper. Applicant respectfully traverses the rejection.

Mayer et al. and *Reid et al.* have been discussed above and the combination of *Mayer et al.* and *Reid et al.* does not teach, show or suggest an anolyte chamber being separated from a catholyte chamber by an ionic membrane, as recited in claims 1, 10, which claims 4, 11, 12, 17 and 18 are dependent thereon.

Dahms et al. teaches an electrolytic method for plating copper on printed circuit boards by applying current pulse or voltage pulse and adding additives such as oxygen-containing, high molecular weight compounds and sulfur compounds with appropriate functional groups, such as bis-(w-sulfopropyl)-disulfide, disodium salt. *Dahms et al.* does not teach, show, or suggest an anolyte chamber being separated from a catholyte chamber by an ionic membrane, as recited in claims 1, 10, which claims 4, 11, 12, 17 and 18 are dependent thereon. Accordingly, *Mayer et al.* in view of *Reid et al.*, and further in view of *Dahms et al.*, alone or in combination, does not teach, show, or suggest positioning the substrate in a catholyte solution contained in a catholyte chamber of a plating cell and applying a plating bias between the substrate and an anode positioned in an anolyte chamber of the plating cell, the anolyte chamber being separated from the catholyte chamber by an ionic membrane and being supplied with an anolyte solution, wherein the catholyte solution comprises one or more additives and the difference between the catholyte solution and the anolyte solution is that the catholyte solution comprises the one or more additives, as recited

in claims 1, 10, and claims dependent thereon. Withdrawal of the rejection is respectfully requested.

Claims 31 stands rejected under 35 U.S.C. 103(a) as being obvious over *Mayer et al.* in view of *Reid et al.*, and further in view of *Sendai et al.* (US Patent Application No. 2003/0057098). The Examiner states that the difference between *Mayer et al.* and the instant claims is that *Mayer et al.* does not explicitly teach tilting the anode and *Sendai et al.* teaches a method and apparatus for tilting the anode at an angle from 1-10° with respect to the horizontal plane so as to be parallel to the substrate (paragraph 91). The Examiner also states that it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the electroplating method of *Mayer et al.* by tilting the anode as taught by *Sendai et al.*, because it would improve the uniformity of the metal film (paragraph 90). Applicant respectfully traverses the rejection.

Mayer et al. and *Reid et al.* have been discussed above and the combination of *Mayer et al.* and *Reid et al.* does not teach, show or suggest an ionic membrane nor separating an anolyte chamber from a catholyte chamber by the ionic membrane, wherein the ionic membrane is positioned at a vertical position above the anode and in substantially parallel relationship to an upper surface of the anode, as recited in claim 29, which claim 31 is dependent thereon.

Sendai et al. discloses an electro-chemical plating system having a tilt mechanism and a head portion for holding a substrate, and a method of immersing the wafer by tilting the substrate in an inclined angle of α which is 1° to 10°. (*See*, Figures 1-9 and paragraphs 0022-0025.) *Sendai et al. also* discloses that, after the surface of the substrate is immersed into a plating solution of a plating cell, the substrate is brought back to a horizontal position for processing the substrate, when the plating cell is stationed horizontally. (*See*, Figures 3-4 paragraphs 0022-0025 and 0080-0087.) Alternatively, when the plating cell and the anode therein is stationed at an inclined angle of β, *Sendai et al.* discloses tilting the substrate in an inclined angle of β before and after the surface of the substrate is immersed into a plating solution of a plating cell without having to brought the substrate back to horizontal such that the substrate

and the plating cell are tilted at the same inclined angle of β during both immersion and plating processes. (*See*, Figures 11-12 and paragraphs 0091-0096.)

Sendai et al. does not teach, show, or suggest an ionic membrane nor separating an anolyte chamber from a catholyte chamber by the ionic membrane, wherein the ionic membrane is positioned at a vertical position above the anode and in substantially parallel relationship to an upper surface of the anode, as recited in claim 29, which claim 31 is dependent thereon. In addition, there is no suggestion or motivation in the combination of the references to combine the teachings. Accordingly, *Mayer et al.* in view of *Reid et al.*, and further in view of *Sendai et al.*, alone or in combination, do not teach, show, or suggest positioning a substrate in a catholyte solution contained in a catholyte chamber of a plating cell, the catholyte solution comprising a copper source at a concentration of between about 0.8M and about 0.9M and one or more additives, and applying a plating bias between the substrate and an anode positioned in an anolyte chamber of the plating cell, the anolyte chamber being separated from the catholyte chamber by an ionic membrane and being supplied with an anolyte solution comprising a copper source at a concentration of greater than about 51 g/L, wherein the ionic membrane is positioned at a vertical position above the anode and in substantially parallel relationship to an upper surface of the anode, as recited in claim 29, which claim 31 is dependent thereon. Withdrawal of the rejection is respectfully requested.

In conclusion, the references cited by the Examiner, alone or in combination, do not teach, show, or suggest the invention as claimed.

Having addressed all issues set out in the Final Office Action, Applicant respectfully submits that the claims are in condition for allowance and respectfully request that the claims be allowed.

Respectfully submitted,

Keith M. Tackett
Registration No. 32,008
PATTERSON & SHERIDAN, L.L.P.
3040 Post Oak Blvd. Suite 1500
Houston, TX 77056
Telephone: (713) 623-4844
Facsimile: (713) 623-4846
Attorney for Applicant(s)